duct. The remainder is usually supplied by finned tubing located along the sides of the car near the floor to prevent drafts about the feet.

RAILWAY PASSENGER CAR SUMMER AIR CONDITIONING

Three general types of refrigerating equipment are being used in conditioned railway cars and rail motor cars in the United States. Of these approximately 23 per cent use ice, 19 per cent use steam jet systems, and 58 per cent employ mechanical compression refrigeration systems. The systems were modified somewhat to meet the requirements of mobile service.

Air cooled or evaporative condensers are always used, with the result that mobile cooling equipment operates at higher temperature, pressure, and power requirement levels than stationary equipment.

The maximum cooling and dehumidifying load may vary from 60,000 to 96,000 Btu per hour per car. An average ice-activated system for such capacities uses about 500 lb of ice and 1.2 kw per hour. The increase in car weight due to such a system is approximately 8500 lb.

A steam jet system will require 180 lb of steam and 3.3 kw per hour, and will add weight per car of 8000 lb.

With mechanical compression systems, all of which use dichlorodifluoromethane as a refrigerant, the problem of driving the compressor (approximately 10 hp) is complicated by the necessity of having motive power available at all times whether the car is in motion or standing still on the right-of-way or in a terminal where auxiliary power plug-ins are available. Where compressors are driven from car axles, additional refinements in the drive are necessary in order to obtain the required cooling capacity from a variable speed power source. Numerous schemes for generating sufficient electrical energy from the car axle for lighting, ventilation, and summer air conditioning are in use, and their operation is closely interlocked with compressor demands, battery charging, etc. It is difficult therefore to estimate the weight of a compression air conditioning system, but it is probably in the vicinity of 6000 to 8000 lb. The power required by such systems is from 5 to 10 per cent of the total locomotive power.

Several schemes for relieving the locomotive of this compression load are used. Some of the articulated trains, which run as unit equipment—the same cars always in the same train—employ a head-end, engine-generator unit for supplying power to compressor motors. In other cases, especially in many of the new streamlined trains, propane fueled engine-driven generators on individual cars are used to supply power to motors, and power for car lighting and accessories. Gas engine compressor combinations on individual cars provide attractive low weight equipment where automatic engine operation is permissible under all circumstances. Diesel-powered generator units have been used experimentally on individual cars for supplying electrical energy and in some cases waste engine heat has been used either for modulating refrigeration with a reheat cycle or for car heating purposes.

RAILWAY PASSENGER CAR HUMIDITY AND TEMPERATURE CONTROL

Little humidity control has been attempted on cars up to the present time. A certain degree of automatic humidity control is secured with cooling, but the relative humidity obtained depends largely upon the

temperature of the evaporator, which should be below the dew-point temperature of the air. With certain outside atmospheric conditions it may not be possible to operate conventional equipment with a sufficiently low evaporator temperature to reduce the humidity without dropping the temperature too low.

There is at present a trend toward the reheat system in which the evaporator temperature is carried sufficiently below the dew point to obtain proper dehumidification; the dehumidified air is then heated to the proper dry-bulb temperature for comfort by passing it over a steam coil, or a coil heated by high temperature liquid from the condenser. Where an internal combustion engine is used as a power source the waste engine heat can be used to good advantage for reheating the dehumidified air.

During the heating season a steam or water spray controlled by a humidistat can provide moisture for humidification, but unless properly controlled, condensation will appear on the windows. There are several cars using this feature.

Temperature control, by thermostats and relays capable of withstanding vibrations, is usual equipment. Manual zone control for varying outdoor conditions, as well as controls which regulate the car temperature automatically in accordance with outdoor conditions, are employed.

A system coming into extended use has a thermostat controlling the dry-bulb temperature, and reset by the wet-bulb temperature, in order to approximate best comfort conditions.

Simplified controls from the standpoint of operation by train crews and especially from the servicing viewpoint are very desirable. The control of summer temperatures is accomplished mainly by cycling the complete cooling system; however, modulation is being effected by using multiple evaporators in which a fixed portion may automatically be cut out of operation to suit the cooling capacity requirements and to keep the equipment in operation for longer periods. With motor or engine driven compression equipment modulation of compressor capacity to suit the reduced evaporator capacity is accomplished by changing motor or engine speed, or by varying the number of compressor cylinders in operation.

For further information on controls, see Chapter 34.

PASSENGER BUS SUMMER AIR CONDITIONING AND VENTILATION

The highways in the United States are now traveled by thousands of air-conditioned passenger buses. Many of the facts stressed in connection with the design and installation of summer conditioning equipment in railway cars are even more important in these newer vehicles. Weight and space limitations are more stringent, and the problem of circulating from 900 to 1200 cfm of air in coaches carrying from 25 to 40 passengers with about 35 cu ft of space per passenger without drafts is not easy to solve.

Some bulkhead delivery systems have been used and, while the overhead package racks have served to break up drafts to some extent, these installations are not gaining in popularity. Longitudinal ducts in the corners above the package racks are sometimes used to carry conditioned air to a series of outlet louvers along the top of the windows. Other designs provide for false spaces below the package racks which serve as ducts to distribute air to entrainment grilles in the bottom of the racks